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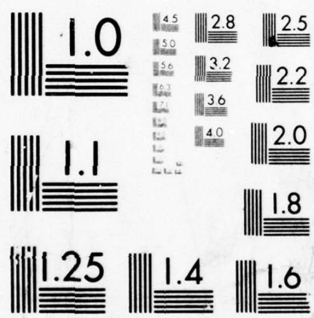
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EVALUATION OF MAINTENANCE OPTIONS FOR AN/ACQ-5 DATA TERMINAL SET

March 1975

Prepared for

NAVAL AIR SYSTEMS COMMAND
Washington, D.C.

under Contract N00019-74-C-0403

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Prepared by

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ABSTRACT

Four proposed maintenance options for the AN/ACQ-5 Data Terminal Set of the P-3C aircraft are comparatively evaluated. Recommendations are offered concerning the most cost effective choices.

ABBREVIATIONS

AIMD	- Aircraft Intermediate Maintenance Department
ATE	- Automatic test equipment
BCM	- Beyond capability of maintenance
BITE	- Built-in test equipment
CONUS	- Continental United States
DOP	- Designated overhaul point
FEB	- Fabricated electronic board
FSP	- Forward stockage point
I	- Intermediate (-level maintenance)
ID	- Interconnect device
IMA	- Intermediate maintenance activity
LORR	- Level of Removal and Repair (model)
MTTR	- Mean time to repair
NAFI	- Naval Avionics Facility, Indianapolis
NAMT	- Naval Air Maintenance Training
NARF	- Naval Air Rework Facility
NAS	- Naval Air Station
NAVAIRSYSCOM	- Naval Air Systems Command
NWESA	- Naval Weapons Engineering Support Activity
O	- Organizational (-level maintenance)
PGSE	- Peculiar ground support equipment
PIMA	- Primary intermediate maintenance activity
S/SE	- Support of support equipment
SM&R	- Source, maintenance, and recovery (code)
SRA	- Shop replaceable assembly
SSP	- Spares stockage point
TBI	- Test bench installation
WRA	- Weapon replaceable assembly

SUMMARY

ARINC Research Corporation has assisted the Naval Air Systems Command in a comparative evaluation of four maintenance-support options for the AN/ACQ-5 Data Terminal Set of the P-3C aircraft. It is intended that the selected option supersede the present maintenance approach.

A maintenance-support cost analysis utilizing the ARINC Research Level-of-Removal-and-Repair (LORR) model revealed that the apparent choice is between two options that are equally cost-effective: Option 1 (no IMA), and Option 3 (four prime IMAs, or PIMAs). The remaining two options (full IMA and two PIMA) were found to be less cost-effective, primarily due to:

a. The high cost of test bench installations for the full-IMA option

b. The high cost of spares for the two-PIMA option.

It should be noted that by a change in one assumption in the two-PIMA option (i.e., the use of forward stockage points), that option would become competitive.

Application of the LORR model also revealed that selective discard, instead of repair, of certain shop replaceable assemblies would reduce the maintenance-support costs of each of the proposed options.

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CHAPTER ONE

INTRODUCTION

Under Contract N00019-74-C-0403, the Naval Air Systems Command assigned ARINC Research Corporation the task of analyzing four maintenance-support options for AN/ACQ-5 Data Terminal Set of the P-3C aircraft.

The analysis was performed to evaluate four maintenance options for the AN/ACQ-5 defined by NAVAIRSYSCOM. An alternative to the present maintenance approach is being sought to improve the efficiency of maintenance by increasing the percentage of time that faults in the AN/ACQ-5 can be isolated at pre-depot levels to specific modules. Two new types of peculiar ground support equipment (PGSE) manufactured by GTE Sylvania were to be considered in the analysis: a Data Terminal Test Set (Mark II) for application at the organizational and intermediate maintenance levels; and a Data Loop Test Set (Echo Box), for use at the organizational level only.

Section 2 of this report presents background information for this investigation, describing the AN/ACQ-5 Data Terminal Set; the present maintenance concept; problem areas being experienced with the present concept; and the proposed maintenance options.

Section 3 gives the results of a cost effectiveness analysis of the four options, describing the mathematical model used for that purpose and defining all data inputs to the model.

The major conclusions and recommendations of this study are presented in Section 4.

CHAPTER TWO

BACKGROUND

2.1 SYSTEM DESCRIPTION

2.1.1 Function

The AN/ACQ-5 Data Terminal Set provides a high-speed digital-data communications link for transmission of tactical information between the P-3C aircraft and other aircraft or surface-based tactical support centers. Data transmission, computer-controlled in the aircraft, is by HF or UHF radio; and is in a serial-bit-stream digital form. A net control station cperates as the key command center, performing the interrogation, transmission, and reception of computer-stored data. The aircraft's central computer processes, stores, and initiates the display of the data.

The AN/ACQ-5 comprises the following units (weapon replacable assemblies) and modules (shop replaceable assemblies):

Unit (WRA)	Quantity of Modules (SRA)
Convertor-Control, CV-2528/ACQ-5	116
Control Monitor, C-7790/ACQ-5	13
Power Supply, PP-6140/ACQ-5	12

2.1.2 Construction and Packaging

The AN/ACQ-5 is of solid-state design and modular construction. The only moving parts in the set are the cooling blowers.

Built-in-test-equipment (BITE) circuitry is used to isolate system failures to the module level. All modules are plug-in types that do not require special tools for removal, and which can be exchanged without the need for electrical adjustments.

The set contains both analog and digital type modules. The analog modules within the CV-2528 and C-7790 units consist of high-density, miniaturized, discrete components mounted on printed circuit boards; while the analog modules of the PP-6140 are larger, containing densely packaged, standard-size components mounted on small plug-in subchassis.

The digital modules contain integrated circuits mounted on printed circuit boards called "FEBs" (fabricated electronic boards).

2.2 PRESENT MAINTENANCE CONCEPT

2.2.1 Organizational Level

Maintenance actions at the organizational (O) level include periodic inspection and cleaning of air filters on the CV-2528 and PP-6140 units, system readiness testing, and fault isolation to a replaceable module. Fault isolation is accomplished by utilizing BITE and a multimeter.

P-3C O-level activities are provided with maintenance module caddies that contain a selection of known-good AN/ACQ-5 modules. The use of these modules from the caddy, for troubleshooting purposes only, facilitates the isolating of a malfunction to a single replaceable module in those cases where BITE indication is limited to a functional group of modules. A system readiness test is performed after module replacement to verify that the malfunction has been corrected.

2.2.2 Intermediate Level

No intermediate (I) level maintenance is authorized under the present maintenance concept.

2.2.3 Depot Level

Maintenance actions beyond the capability of maintenance (BCM) at the O-level are accomplished at a designated overhaul point (DOP). Depot maintenance includes screening and repair or other disposition of AN/ACQ-5 assemblies returned from the O-level. The DOP is presently maintained by the manufacturer, Sylvania Electronic Systems Group, under an Aviation Supply Office repair-of-repairables contract. The Navy DOP, when established, will utilize automatic test equipment (ATE) to support the AN/ACQ-5. No requirements for peculiar ground support equipment are anticipated.

2.3 PROBLEM AREA IDENTIFICATION

A review by ARINC Research of 3M maintenance data reports for P-3C aircraft demonstrated quantitatively that the AN/ACQ-5 is not being supported according to the present maintenance concept. That concept requires fault isolation to the defective module at the O-level, using BITE and module substitution. A survey of 3M maintenance reports for the period August 1973 through July 1974 indicates that of the total removals reported for the CV-2528 unit (including its shop replaceable assemblies), the complete unit was removed 10% of the time. For the C-7790, the complete unit was removed 60% of the time; and for the PP-6140, 75%.

The heavy influx of complete WRAs back to the DOP has presented a problem. The weapon replaceable assemblies have source, maintenance and recoverability (SM&R) codes for PBODD (insurance buy only), and were not provisioned for general replacement.

Since the present maintenance concept for the AN/ACQ-5 Data Terminal Set has proven to be an ineffective one, and since GTE Sylvania has introduced new PGSE that promises to provide improved fault isolation, NAVAIRSYSCOM is seeking a new maintenance approach. That organization has defined four options to the present concept, which ARINC Research has been asked to evaluate from a cost-effectiveness standpoint. The four options are described in the next section.

2.4 PROPOSED MAINTENANCE OPTIONS

Each of the four AN/ACQ-5 maintenance options includes use of the Data Loop Test Set (Echo Box) at the O-level (one per P-3C squadron), and individually considers use of the Mark II Data Terminal Test Set at both the O- and I-level.

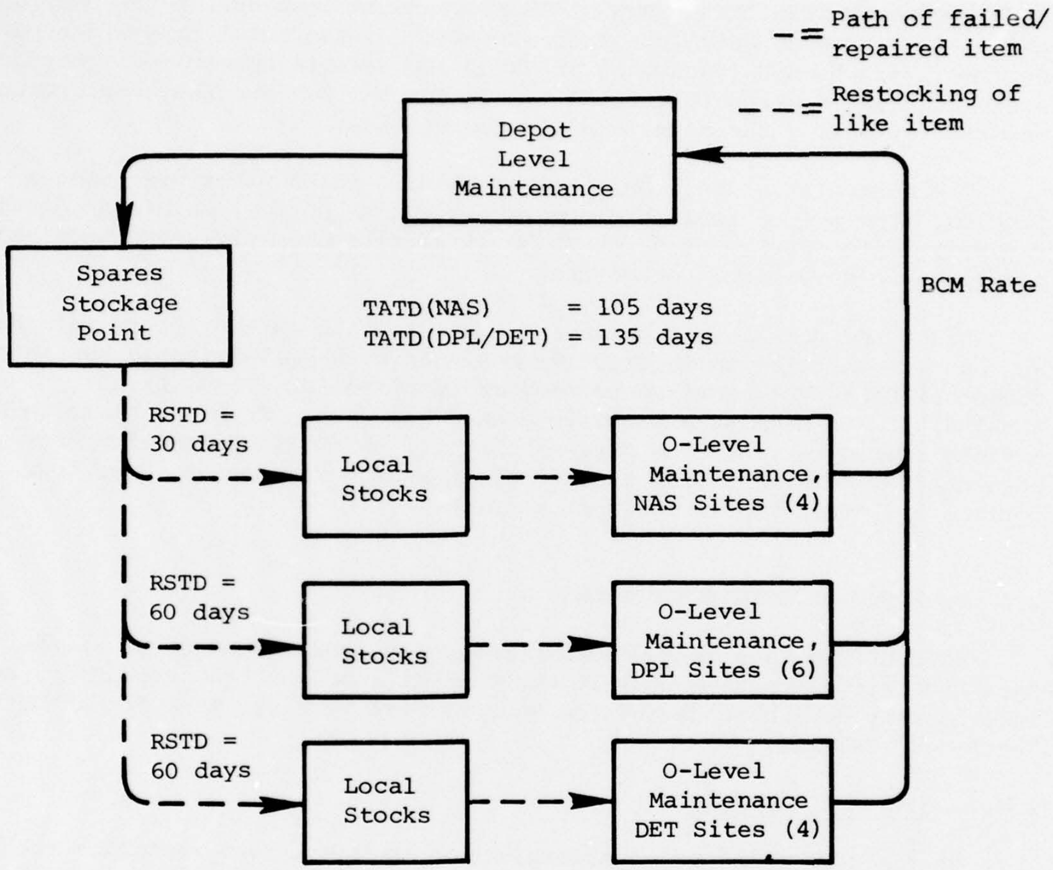
2.4.1 Option 1 (No IMA)

Of the four maintenance alternatives, Option 1 most resembles the present maintenance concept in that no support of the AN/ACQ-5 would be provided at the intermediate maintenance activity (IMA) level. One Mark II test set would be assigned to each P-3C squadron for use in the aircraft (in addition to the present BITE and module buddy kit) for fault isolation to the module level. Under this approach, it is expected that fault isolation to modules would be accomplished 95% of the time.

All removed items would be returned to the selected Naval Air Rework Facility (NARF) for screening and fault isolation using ATE, followed by repair or other disposition. The spares support loops required for this option are shown in Figure 1.

Under this option, additional training would be required for O-level technicians.

WRA removed at A/C; repaired at depot.
BCM Rate = 5% of total removal rate = MRF
SRA removed at A/C; repaired at depot only.



Abbreviations:

BCM = Beyond capability (of local) maintenance
DET = Detachment
DPL = Deployed
MRF = Maintenance replacement factor
NAS = Naval Air Station
RSTD = Resupply time, depot
RSTF = Resupply time, forward
TATB = Turnaround time, base
TATD = Turnaround time, depot
TATF = Turnaround time, forward

Figure 1. SPARES INVENTORY FLOW DIAGRAM, OPTION 1 (NO IMA)

2.4.2 Option 2 (Full IMA)

Option 2 provides that every IMA for the P-3C aircraft be designated to perform I-level repair on the AN/ACQ-5. A test bench installation (TBI) would be established at each IMA, with the TBI consisting of AN/ACQ-5 WRAs electrically connected to form a complete set; a Mark II test set; and interconnecting wiring. Each TBI would also require a module caddy kit. Training would be required for I-level technicians.

Fault isolation on the aircraft would be to the SRA level, at the same ratio of WRA to SRA removals now being experienced. The WRAs would be repaired at the IMA (except for "BCM" items) by replacing defective SRAs. All SRAs and the BCM portion of WRA removals would be sent to the selected NARF for repair. The NARF would utilize ATE as in Option 1. The spares support loops for Option 2 are illustrated in Figure 2.

2.4.3 Option 3 (Four Primary IMA's)

Option 3 considers a modified full-IMA approach in which I-level maintenance is performed at only two CONUS and two deployed sites. These primary IMAs (PIMAs) would be equipped with a TBI as described in Option 2, and the fault isolation level would also be the same. WRA repairs would be at the PIMAs, with both WRAs and SRAs repairable at the selected NARF. Training would be required for I-level technicians assigned to the aircraft intermediate maintenance department (AIMD) at each PIMA site.

Each site without IMA capability would be supported by a PIMA, with a turnaround averaging about 17 days for all items removed at O-level. Each PIMA site would have a forward stockage point (FSP), with spares for the forward pipeline similar to the backup spares for the depot pipeline. At the PIMA, WRAs repaired and SRAs found to have no defect would be sent directly to the FSP. The remaining WRAs and SRAs would be forwarded to the NARF for repair or other disposition. A graphical presentation of this spares support concept, illustrating the spares loops involved, appears as Figure 3.

2.4.4 Option 4 (Two Primary IMA's)

Option 4 also considers a modified full-IMA approach, with I-level maintenance performed at only two selected CONUS sites. The levels of fault isolation and repair, as well as the training of PIMA technicians, would be the same as for Option 3.

Option 4 differs from Option 3 primarily in that the former would have no FSPs. At the PIMA, repaired WRAs and SRAs found to be not defective would be sent directly to the central spares stockage point (SSP). The remaining WRAs and SRAs would be forwarded to the NARF for repair or other disposition. Resupply would be to each site's local stocks from the central SSP. This concept is depicted graphically in Figure 4.

WRA removed at A/C; repaired at IMA/depot
BCM Rate = 5% of WRA removal rate = MRF
SRA removed at A/C and IMA; repaired at depot only

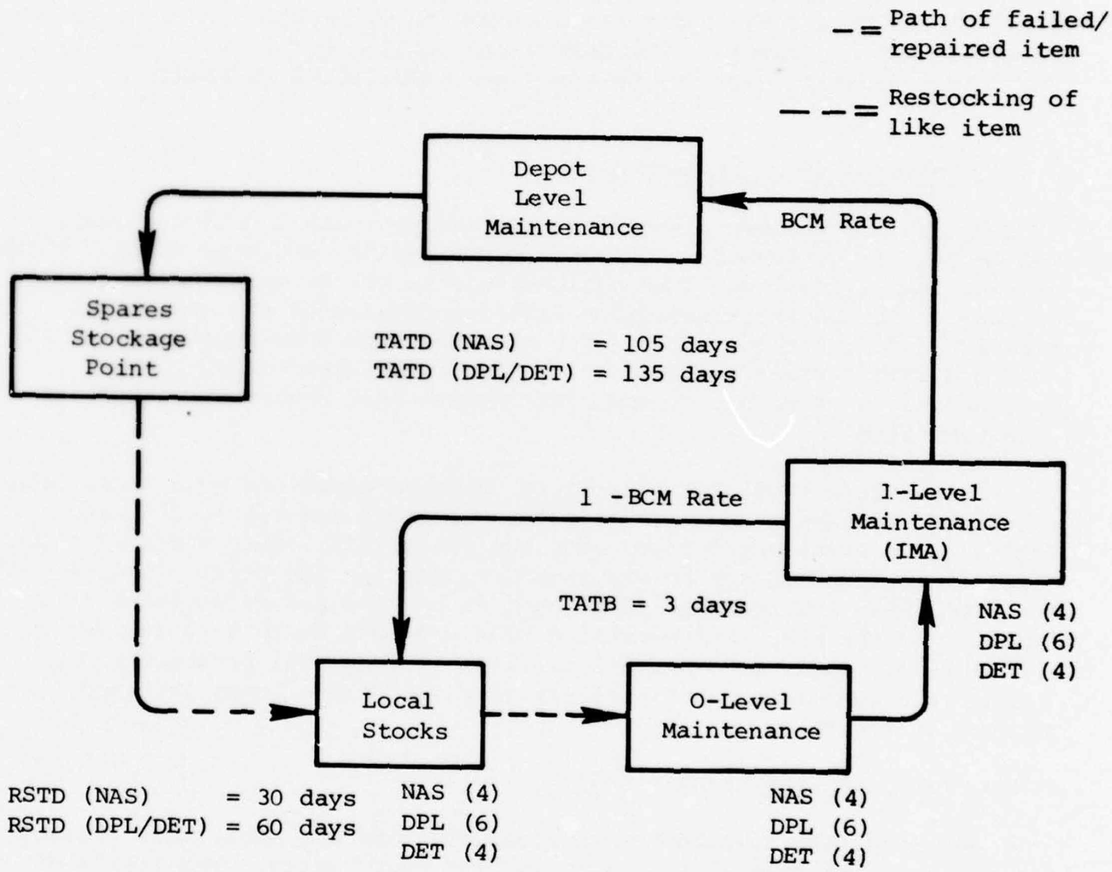


Figure 2. SPARES INVENTORY FLOW DIAGRAM, OPTION 2 (FULL IMA)

WRA removed at A/C; repaired at PIMA/depot.
BCM Rate = 5% of WRA removal rate = MRF
SRA removed at A/C and PIMA; repaired at depot only.

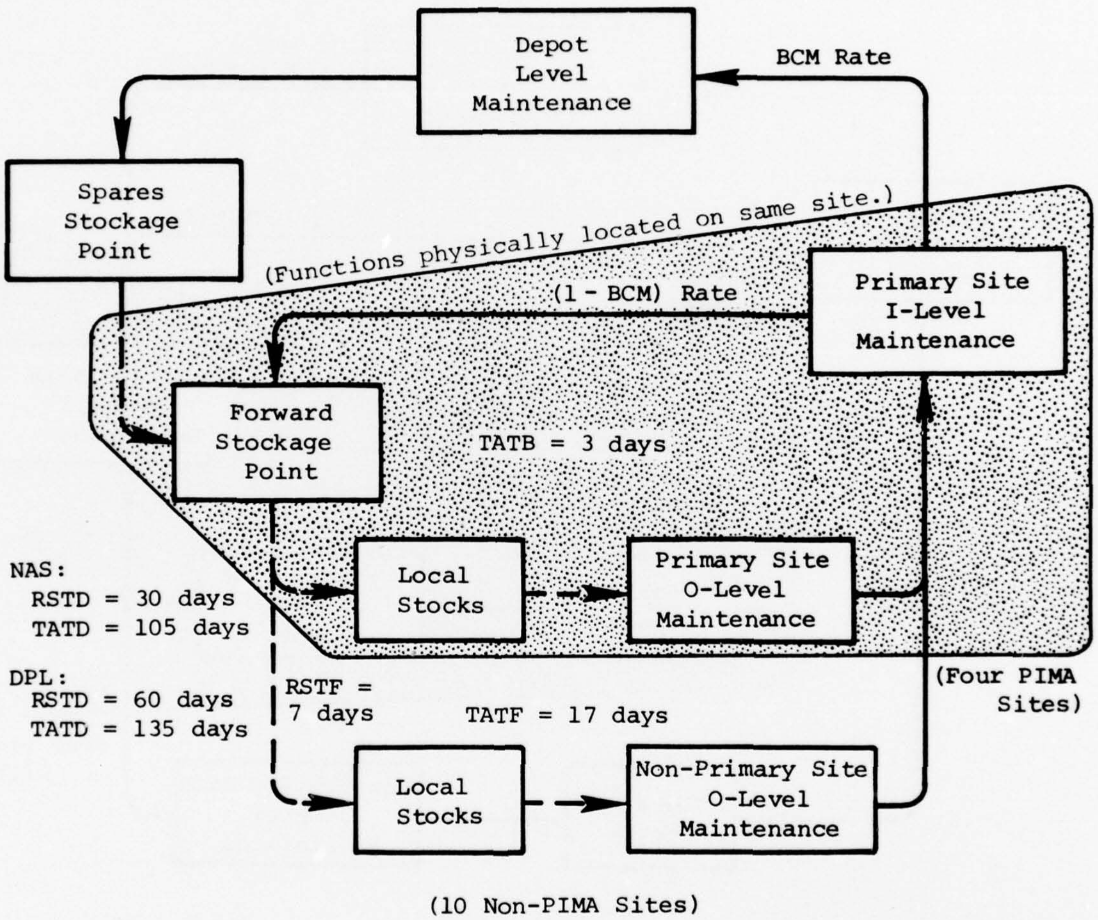


Figure 3. SPARES INVENTORY FLOW DIAGRAM, OPTION 3 (FOUR PIMAs)

WRA removed at A/C; repaired at PIMA/depot
BCM Rate = 5% of WRA removal rate - MRF
SRA removed at A/C and PIMAs; repaired at depot only

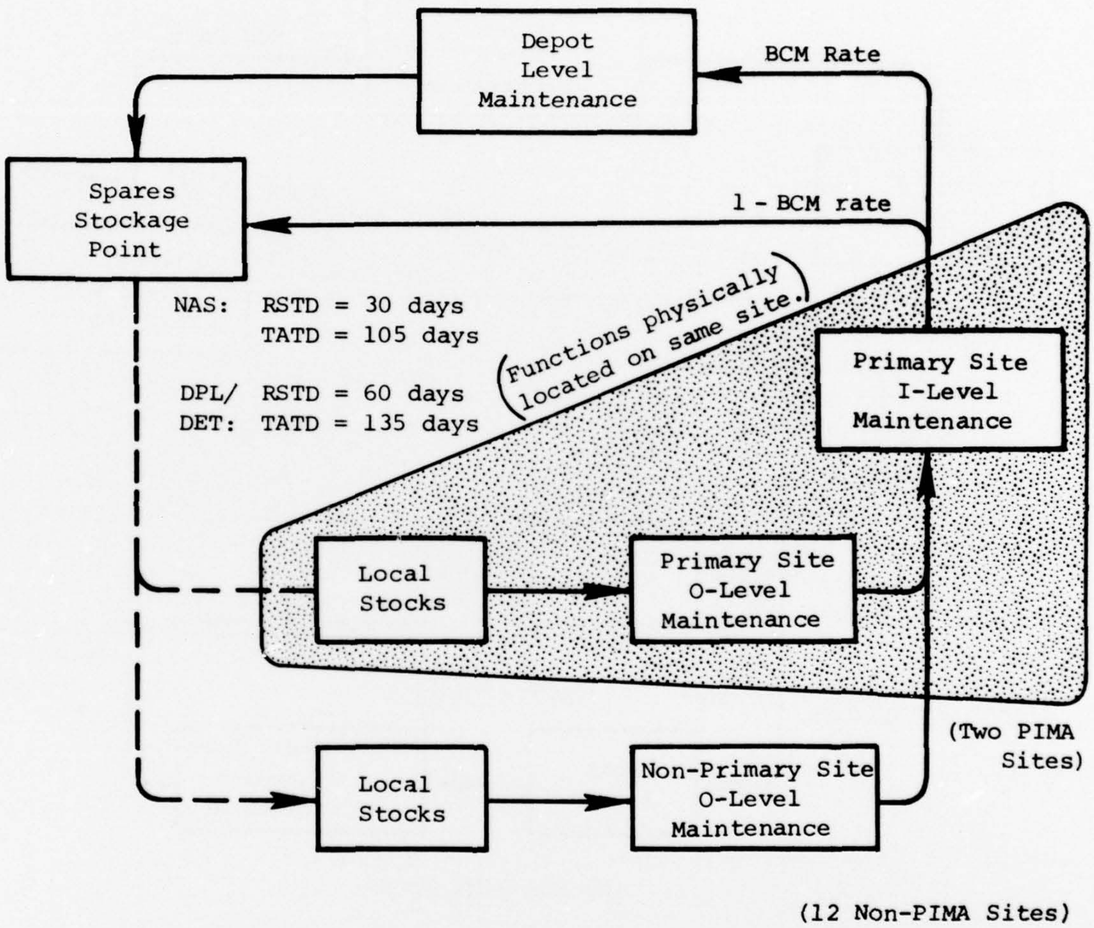


Figure 4. SPARES INVENTORY FLOW DIAGRAM, OPTION 4 (TWO PIMAs)

CHAPTER THREE

LEVEL-OF-REMOVAL-AND-REPAIR ANALYSIS

3.1 LORR MODEL

To evaluate the cost effectiveness of the four maintenance options for the AN/ACQ-5 Data Terminal Set, ARINC Research Corporation applied its previously developed Level-of-Removal-and-Repair (LORR) model. The LORR Model is similar to that described in MIL-STD-1390A (formerly AR-60), a general level-of-repair approach applicable to all Navy avionics. The ARINC Research model utilizes many of the cost-estimating relationships of MIL-STD-1390A, such as those for computing the cost of personnel utilization.

The LORR model computes life cycle costs of maintenance support elements peculiar to each WRA, as functions of the removal and BCM rates of the WRA and its SRAs. WRA-peculiar cost elements include:

a. Spares

b. Spares Storage

c. Transportation

d. Labor

e. Material

f. Entry/Retention

Certain other cost elements are not considered to be WRA-peculiar, i.e.,

a. PGSE

b. Facilities requirements

c. Training

The latter are added as system (AN/ACQ-5) costs after WRA-peculiar costs are computed. This cost-separating feature of the LORR model permits optimization of the maintenance policy on an individual-SRA basis.

As part of this analysis, ARINC Research considered effects of repair-versus-discard policy of SRAs for the four maintenance options. It was presupposed that, although savings may be realized by procuring SRA support (fault-isolation) equipment rather than establishing a general discard policy, costs might be further reduced by the practice of discarding certain low-cost SRAs. The LORR model has the capability of optimizing the repair/discard mix, i.e., selecting the specific SRAs that should be discarded rather than fixed.

3.2 LORR APPLICATIONS TO AN/ACQ-5

Application of the LORR model to the AN/ACQ-5 was based on planning data from the NAVAIRSYSCOM P-3 Weapon System Planning Document, dated 18 January 1974; and from current Squadron Employment Plans, undated, for the P-3C weapon system. These documents indicate that during the 10-year life cycle of the P-3C, 14 sites are expected to be outfitted for aircraft operation -- four CONUS-based naval air stations and 10 deployment sites. The latter include four sites with full deployment schedules, four with detachments, and two contingency sites to be supported by maintenance vans. Not all of these sites will be active for the complete life cycle. Information concerning activation dates and operating levels are available in the referenced documents, which are classified Confidential.

The ARINC Research LORR model has the capability of considering numerous possible maintenance-support options. In this analysis, the model was utilized only to perform a cost comparison between the four maintenance support options under consideration.

A number of input parameters are required by the model to account for the peculiarities of each avionics subsystem and the various maintenance options. Three general categories of parameters include those inputs that 1) differ among options, 2) are peculiar to each WRA and SRA, and 3) are constant over all options and hardware items.

3.2.1 Option Peculiar-Parameters

The input parameters that differ among options are a function of the quantity of sites with a particular level of maintenance capability. Table 1 summarizes this information for the four maintenance options. Shown in the table are the total number of sites expected to be outfitted during the P-3C life cycle; these quantities were used in calculating spares requirements.

The data of Table 1 include the two deployment sites that would be supported by maintenance vans. Table 1 also shows the types of sites with IMA capability in the PIMA options. In Option 4 (two PIMA), both PIMA

Table 1. PARAMETERS PECULIAR TO FOUR MAINTENANCE OPTIONS				
	Maintenance Support Option			
Parameter	1) No IMA	2) Full IMA	3) 4 PIMA	4) 2 PIMA
Quantity of NAS Sites:				
With IMA	0	4	2	2
Without IMA	4	0	2	2
Quantity of Full Deployment Sites:				
With IMA	0	6	2	0
Without IMA	6	0	4	6
Quantity of Detachment Sites:				
With IMA	0	4	0	0
Without IMA	4	0	4	4
Local SRA MTTR (hr)	0.5	N/A	N/A	N/A

sites are CONUS-based NASs. For Option 3 (four PIMA), the two additional PIMA sites are deployment sites.

The significance of the 0.5-hour MTTR for Option 1 (no IMA) is to account for use of the Mark II test set in the aircraft when fault-isolating to the SRA level. That value is not used to calculate local repair costs of the SRA, since no actual local repair of the SRA is considered in any of the four options.

3.2.2 WRA/SRA Variable Parameters

Input parameters that differ for each WRA and SRA are listed in Table 2. These inputs determine cost variations peculiar to a specific repairable item.

Predicted failure rates, along with a factor for converting failures per operate hour to removals per flying hour, were applied to each WRA and SRA. 3M data on actual removals were used to derive the conversion factors for WRAs; however, the corresponding factors for SRAs could not be

Table 2. PARAMETERS THAT DIFFER FOR EACH WRA AND SRA
Part number
Failure rate (base portion)
Failure rate (depot portion)
Cost
Quantity per system
Scrappage rate

directly computed since 3M data are incomplete at that level. This means that many removals were not reported for SRAs that were in fact faulty and resulted in the removal of WRAs.

Since it was not possible to relate WRA removals to particular SRAs by means of 3M data, an alternate approach was taken. This approach compares the total actual removal rate for each WRA (including SRA removals) with the total predicted rate for each WRA (including SRA failures) to derive a conversion factor for each WRA. These conversion factors were input to the model to convert predicted failure rates to removal rates. The following conversion factors were established:

WRA	Conversion Factor
CV-2528	1.589
C-7790	1.865
PP-6140	1.541

Complete WRA repair data are not available; however, limited data have shown that only a small percentage of the WRA removals were valid. Therefore a BCM rate of 5% was estimated to calculate the depot portion of the failure rate. The BCM rate of 5% was applied to the total failure rate for each WRA. The WRA failure rate is the sum of the predicted failure rates for all of the SRAs contained in the WRA.

For the three options requiring I-level maintenance, the base portion of the WRA failure rate was determined by subtracting the depot and SRA portions (the latter is that failure rate resulting in SRA removal and replacement at the O-level) from the total WRA failure rate. The percentages for each WRA were given in Section 2.3.

This method of apportioning WRA removals to base and depot rates was employed with the approval of NAVAIR-4112A, and is premised on the assumption that O-level technicians can continue to fault-isolate the ACQ-5 subsystem to the same level as they have in the past. The results of this analysis are very sensitive to this assumption, since a maintenance concept of WRA removal for each WRA/SRA failure would greatly increase the spares inventory costs for all I-level options and tend to eliminate them from consideration.

Since all SRAs are to be repaired at the depot, there is no base portion of the failure rate. The BCM rate for SRAs is 100 percent.

The unit cost values used for each repairable item were provided by the Aviation Supply Office, Philadelphia, during calendar year 1973 for an earlier ARINC Research study. The remaining data were obtained from the AN/ACQ-5 provisioning parts breakdown.

3.2.3 Constant Parameters

Constant input parameters to the LORR model are shown in Table 3. These constants consist primarily of the factors entering into the computations for the various support cost elements.

The monthly flight hour inputs are from the previously referenced P-3 Weapon System Planning Document. They are classified Confidential and are therefore not listed in this report.

The flight hours were entered twice for each NAS site. The first entry is a monthly average, representative of the flight-hour level over the full 10-year cycle, and was used to calculate total removals (maintenance events). The second entry was based on flight-hour levels during the last year of the life cycle, and was used to compute spares requirements. The separate calculations were required since some of the sites are not active for the full life cycle. This action was accomplished for the deployment sites by varying the number of sites rather than the flight hours. The use of different methods for NAS and deployment sites was only to accommodate the logic of the model and the same objectives were obtained in each case.

The SRA mean time to repair (MTTR) estimate was provided by NAS Jacksonville technicians. The local/forward MTTR for the WRA is based on Mark II tester use. The depot MTTR estimates for the WRAs are from the Avionics Systems Rework Cost Study, dated 23 February 1973, developed by NARF Alameda.

The turnaround times and resupply times for the forward sites are ARINC Research estimates, based on Navy guidelines for provisioning calculations, and on the results of a logistics support analysis conducted by

Table 3. CONSTANT SUPPORT/COST PARAMETERS FOR AN/ACQ-5 MAINTENANCE OPTIONS

Parameter	Value
Probability of spares sufficiency	0.85
Turnaround time (days):	
Local-local	3
Local-forward	17
Local/forward-depot:	
NAS	105
Deployed	135
Life cycle (years)	10
Flight hours (per month)	Ref. WSPD (see section 3.2.3)
Moffett Field, Cal.*	
Jacksonville, Fla.*	
Brunswick, Maine*	
Patuxent River, Md.*	
Deployed sites (same for each site)	
Deployed detachment sites (same for each site)	
Resupply time (days)	
From FSP	7
From SSP:	
NAS	30
Deployed	60
Round trip transportation cost (dollars):	
Local-forward	11
Local/forward-depot	11
Inventory storage cost (dollars/ft^3/month)	0.50
Average SRA size (ft^3)	0.01
Consumable days of stock (days):	
Local/forward	90
Back-up	180
SRA repair material cost (percentage)	10
Labor cost per manhour (dollars):	
Local/forward	12
Depot	16
MTTR SRA repair at depot (hours)	1.25
MTTR WRA repair (hours):	
Local/forward	0.5
Depot (CV-2528/C7790/PP-6140)	24/20/24

*Entered twice for each site

ARINC Research for a comparable maintenance situation.* The remaining parameters are generally applicable, and were not derived specifically for this report.

3.3 LORR COST ELEMENTS

The cost elements considered in the LORR model are those that vary for each repairable item. This permits evaluation at the lowest repairable level so that a repair/discard decision can be made for each item. It is frequently possible to reduce maintenance-support costs by discarding selected modules, particularly when automatic test equipment such as the ATE 5500 is used for maintenance support.

Item entry and retention costs are usually computed in a LORR analysis, but it was excluded from this report because the costs are the same for each of the four options. ATE programming and interconnect device (ID) costs for each item were input to the model for consideration in the repair/discard decision.

3.3.1 Spares

The total cost of spares is based on the spares required to support four CONUS-based NAS sites and 10 deployed sites for the 10-year life cycle. The number of sites considered was based on the P-3C Weapon System Planning Document and current Squadron Employment Plans. The quantity of deployed sites includes two planned for maintenance-van support.

3.3.2 Spares Storage

Spares storage costs are computed for all spares stored on-site, excluding replenishment items required due to scrappage.

3.3.3 Transportation

Transportation costs are computed for all removals that require shipment from one site to another, whether one-way or round trip. For example, discard actions are performed on-site and thus the replacement part is only sent one way to the site.

3.3.4 Labor

Labor costs are computed for WRA repair at the intermediate and depot levels. In addition, costs are added for the labor required in using the Mark II test set while troubleshooting on the aircraft in the no-IMA option (1). Labor costs are computed for SRA repair at the depot and also

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*ARINC Research Corporation, E-2A/B Aircraft Logistics Support Analysis, publication 952-01-2-1140, dated 31 October 1971.

for use of the Mark II test set while troubleshooting to the SRA on the aircraft in the no-IMA option.

3.3.5 Material

Material cost for SRA repair is the same for each option and would not normally be included in a cost comparison of this type. In this case, however, the cost data are required for the repair/discard decision for each SRA, and were therefore included in the model.

3.3.6 ATE Programming and Interconnect Devices

The cost of ATE programming and interconnect devices for each module are the same for each of the options, and are included in the model only for the SRA repair/discard decision. The input cost estimates were provided by AIR-41122A and are based on estimates provided by cognizant NARF and NAFI personnel. The cost estimates used were $5,000 for programming and $1,000 for IDs per SRA. This element also includes the "support of support equipment" (S/SE) cost for the IDs. The method of calculating the S/SE cost is explained in Section 3.4.3.

3.4 SUBSYSTEM LEVEL COST ELEMENTS

Many of the maintenance-support costs are not WRA-peculiar and were added manually as total system (AN/ACQ-5) costs after WRA-peculiar cost elements were determined. In addition, many system costs do not vary among the options being considered and were not included in the cost total. Such costs might include:

a. PGSE documentation

b. Echo Box hardware, S/SE, and training

c. NAMT PGSE

d. ATE hardware, S/SE, and training

3.4.1 Mark II Hardware

The unit cost estimate of $10,000 for the Mark II test set was provided by a GTE Sylvania representative. The Mark II requirement for each option is:

a. Option 1 (no IMA) - One per squadron.

b. Option 2 (full IMA) - One per site (except two van-supported deployed sites) and one per maintenance van.

c. Option 3 (four PIMA) - One per primary IMA.

d. Option 4 (two PIMA) - One per primary IMA.

3.4.2 Test Bench Installation

The unit cost of $96,780 per TBI includes $70,000 for an AN/ACQ-5 system hardware and $26,780 for the module caddy kit. The additional module caddy kits are required because the kits on hand will still be in use on the aircraft. The TBI requirement for each of the options is:

a. Option 1 (no IMA) - None.

b. Option 2 (full IMA) - One per site (except two van-supported deployed sites) and one per maintenance van.

c. Option 3 (four PIMA) - One per primary IMA.

d. Option 4 (two PIMA) - One per primary IMA.

3.4.3 Support of Support Equipment

The S/SE costs were computed for the Mark II test set using the method and percentages developed by NWESA. The total cost for this element was derived by multiplying the quantity of test sets by the sum of 1) 30 percent of the equipment's unit cost for the first year, and 2) 15 percent of the same unit cost for each year thereafter for a total of 10 years.

S/SE costs for ATE interconnect devices were included in the LORR model (see Section 3.3.6) to be considered in the SRA repair/discard decision. The underlying assumption is that depot level screening is not required for SRA discard; therefore, programming and ID costs (including S/SE for IDs) would not be incurred for discard candidates. Also, since programming, ID, and S/SE costs are constant for each SRA, they were combined in the model for convenience.

3.4.4 Training

For purposes of this analysis, the cost element of training includes only O- and I-level naval air maintenance training (NAMT). The cost of depot level training was considered to be a sunk cost and was therefore excluded. The training cost per man was based on an hourly rate of $14 per hour and a training period of 160 hours (4 weeks). The hourly rate was provided by NAMT personnel and includes all expenses except hardware costs for the trainers. The 4-week training period is an ARINC Research estimate based on requirements for similar P-3C subsystems. The calculations for training include an initial training requirement and an annual personnel attrition rate of 40%.

3.5 RESULTS OF LORR ANALYSIS

3.5.1 Comparison of Options

Results of the cost analysis for each of the four maintenance-support options are given in Table 4. The first subtotal includes costs determined by the LORR model. The remaining cost elements are the system-level costs referenced in Section 3.4.

As shown in the table, Option 1 (no IMA) and Option 3 (four PIMA) are the least costly. Since the model cannot be expected to provide exact results, the totals for these two options should be considered as equivalent. As noted earlier, Option 3 is only cost-effective if O-level support of the AN/ACQ-5 continues with fault isolation to the SRA level equivalent to that experienced in the past.

Option 4 (two PIMA) is not cost-effective, due primarily to the high cost of spares. If this option were to include forward stockage points as defined in the four-PIMA option, it would become a competitive approach.

Only Option 1 (full IMA) is shown not to be cost effective under any of the conditions considered, primarily due to the high cost of test bench installations.

3.5.2 Discard Vs. Repair

In addition to providing a basis for cost comparisons among the four options, the LORR model also permits evaluation of discard-versus-repair cost for each SRA within each of the repair options. Results of exercising the model indicate that a reduction in maintenance-support cost is possible for each of the four options through use of a selective discard policy.

Net cost reductions are possible for SRAs when the increased price of spares is offset by reductions in the remaining cost elements. The cost savings, presented in Table 5, represent reductions in the total support costs (Table 4) of each of the respective options. Specifically they are reductions to be applied at the first subtotal of Table 4, which presents costs for the LORR model cost elements.

A major portion of the cost reduction possible under a selective SRA discard policy is from the elimination of costs for ATE programming and interconnect devices, and the S/SE cost of maintaining the IDs. As mentioned in Section 3.4.3, elimination of these costs is based on the assumption that depot-level screening is not required for SRA discard. ATE programs and IDs would only be required for repairable SRAs. If this assumption is ruled invalid, the discard decision would reverse for many of the SRAs and the information contained in Table 5 would become invalid.

The particular SRAs to be considered for discard in Options 1 and 2 (no IMA and full IMA) are identified by part number in Table 6. The discard candidate list for Options 3 and 4 (four PIMA and two PIMA) include all of the items of Table 6 plus CV-2528 modules P/N 32-161860-0012, -0054, and -0119.

Table 4. COSTS OF MAINTENANCE-SUPPORT OPTIONS FOR AN/ACQ-5

Maintenance Support Cost Element	Option 1: No IMA ($)	Option 2: Full IMA ($)	Option 3: 4 PIMAs ($)	Option 4: 2 PIMAs ($)
a. WRA-Peculiar				
Spares	2,351,646	2,946,644	2,816,493	4,875,496
Spares Storage	605	2,650	2,488	4,893
Transportation	124,625	124,769	131,620	130,052
Labor	439,415	379,555	379,555	379,555
Material	438,974	438,974	438,974	438,974
ATE Programming & ID	1,063,350	1,063,350	1,063,350	1,063,350
SUBTOTAL	4,418,615	4,955,942	4,832,480	6,892,320
b. General				
Mark II Test Set	220,000	160,000	40,000	20,000
Test Bench Installation	0	1,548,480	387,120	193,560
Support of PGSE	363,000	264,000	66,000	33,000
Training (Mark II)	246,400	246,400	44,800	22,400
SUBTOTAL	829,400	2,218,880*	537,920	268,960
TOTAL	5,248,015	7,174,822	5,370,400	7,161,280

*Includes four maintenance vans, except cost of training personnel to work in vans.

Table 5. COST SAVINGS UNDER SELECTIVE DISCARD POLICY

Option	Maintenance Support Cost Reduction ($)
1 - No IMA	272,583
2 - Full IMA	271,605
3 - Four PIMA	286,151
4 - Two PIMA	285,323

Table 6. SRA DISCARD CANDIDATES FOR AN/ACQ-5

a. Convertor-Control (CV-2528/ACQ-5)				
32-161860-0002,	-0005,	-0007,	-0008,	-0009,
-0014,	-0019,	-0020,	-0021,	-0028,
-0029,	-0031,	-0032,	-0033,	-0034,
-0036,	-0038,	-0041,	-0042,	-0043,
-0044,	-0045,	-0048,	-0049,	-0050,
-0051,	-0052,	-0053,	-0055,	-0056,
-0058,	-0060,	-0070,	-0072,	-0073,
-0074,	-0075,	-0077,	-0078,	-0081,
-0082,	-0088,	-0093,	-0094,	-0097,
-0099,	-0109,	-0116,	-0117,	-0118
32-161870-0002,	-0007,	-0009		
89-161538-1				
89-161539-1				
b. Control Monitor (C-7790/ACQ-5)				
32-161860-0004,	-0022,	-0023,	-0037,	-0114,
-0115				
32-161870-0034				
c. Power Supply (PP-1640/ACQ-5)				
32-161751-1				

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

This investigation revealed that more than one maintenance-support option for the AN/ACQ-5 Data Terminal Set is economically feasible. The total costs for the lowest-priced alternatives (no IMA and four PIMA) are substantially the same. If the two-PIMA option were to make allowance for forward stockage points, it would become a competitive alternative. The full-IMA option is questionable due to the high cost of test bench installations.

Based on the critical assumption that depot-level screening is not required for SRA discard, the mixed SRA repair/discard concept of Section 3.5 should further reduce the maintenance-support cost of any of the proposed options.

4.2 RECOMMENDATIONS

Of the four options under consideration, the maintenance support analysis has shown the no-IMA and the four-PIMA options to be equally cost effective. It is recommended that the latitude offered by this situation be used to best advantage by considering other factors, such as suitability of PGSE, in forming the final maintenance-support decision.

It is further recommended that implementation of a selective SRA repair/discard policy receive serious consideration as a means of further reducing maintenance-support costs of the selected option.